

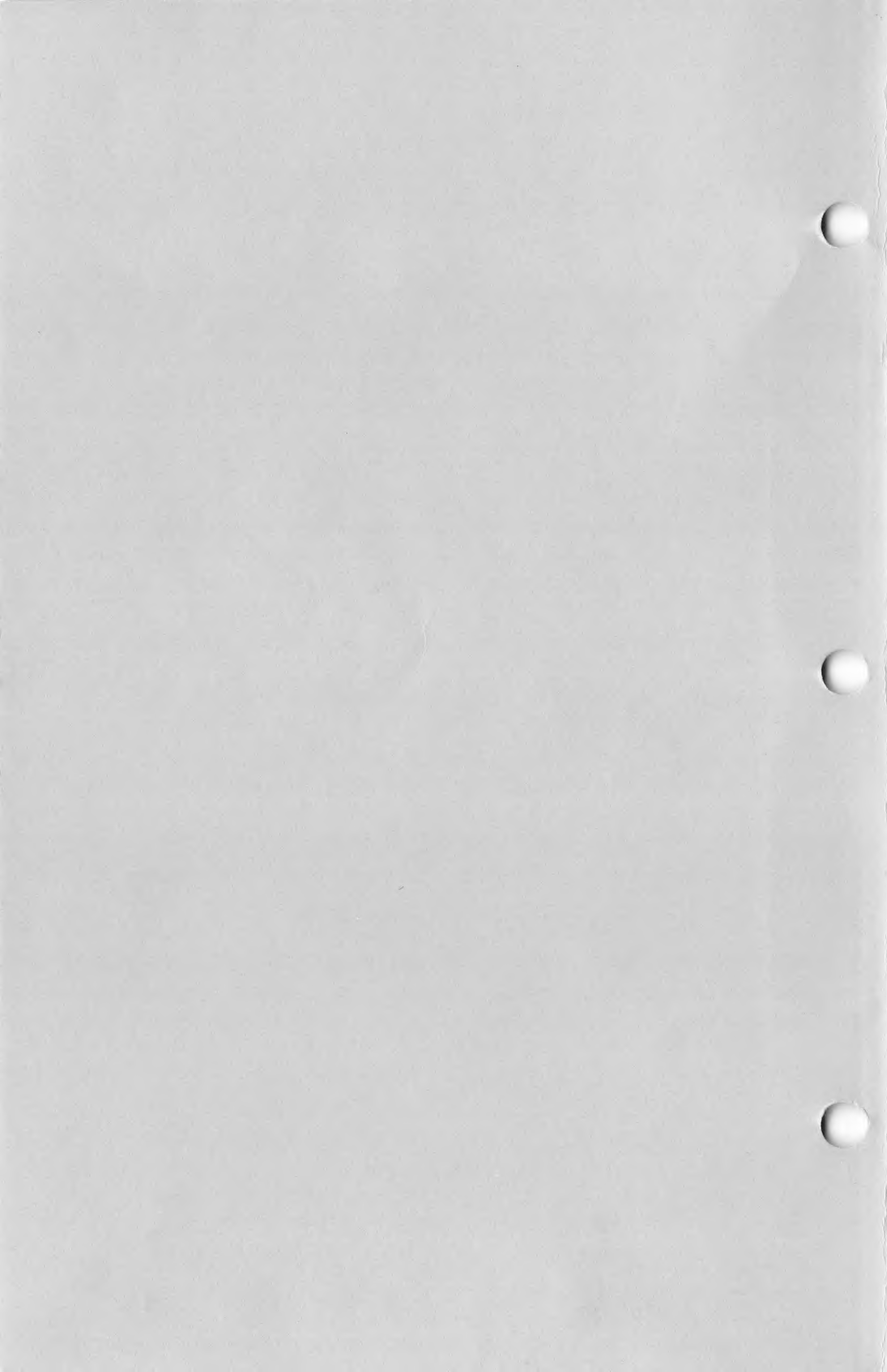
HELIX PC BUBBLE DISK

USER'S MANUAL



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**VERSION 1.0
February 1984**

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THE HELIX PC BUBBLE DISK USER'S MANUAL

INTRODUCTION

The PC Bubble Disk is a bubble memory adapter board for the IBM Personal Computer and compatibles. The board holds four Intel one-megabit magnetic bubble memories, providing 512 Kbytes of non-volatile, solid-state memory.

Like a floppy or hard disk, a bubble memory stores data as magnetic domains that do not require power to be retained. Unlike the above devices, the bubble memory does not have any mechanical moving parts and thus exhibits 20-year mean-time-before-failure reliability even when continuously operated. Bubble memory data is not individually byte-addressable and does not occupy memory address space. Instead, commands and data are sent through an I/O port to the Intel single-chip bubble memory controller (BMC), which is similar to a disk controller, for random I/O operations on blocks of data.

An EPROM on the bubble board contains firmware that makes the Bubble Disk emulate a fixed disk at the BIOS command level. Operating systems that support the fixed disk, including PC-DOS 2.0, Softech Pascal IV.13 and CP/M-86 for the PC/XT, will work with the Bubble Disk without software patches. Fixed disk software features, such as the RESTORE and BACKUP commands, as well as partitioning to hold multiple operating systems, are thus available to the Bubble Disk user. Functionally, a single Bubble Disk board appears to an operating system as a 4 head, 15 cylinder fixed disk with 17 sectors per track.

The on-board EPROM occupies 8 Kbytes of address space (even if a 4 Kbyte 2732 EPROM is installed). The starting address of the EPROM is jumper-selectable for compatibility with other adapter cards, such as the fixed disk adapter. The Bubble Disk works on the IBM PC/XT with a single fixed disk installed and is jumper-selectable to appear before or after the fixed disk drive.

The I/O port address for the board is also jumper-selectable, allowing multiple-board operation of up to four boards, depending on power supply capabilities. Additional boards increase the size of the Bubble Disk drive instead of appearing as individual drives.

The Intel bubble support chips provide built-in 14 bit error checking and correction (ECC) code and power-fail protection circuitry. The four

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bubble memories are operated in parallel for a transfer rate (400 Kbits/sec) four times the single bubble rate. Data transfers are made using the system board's direct memory access (DMA) with an interrupt to signal operation completion. These signal lines are jumper-selectable and tri-stated when not in use.

For full Bubble Disk capabilities, it is important that the target PC have the newer BIOS ROM with the ROM_SCAN routine (release marker 10/27/82 or later). The newer IBM PCs with the 256 Kbyte system board, the newer COMPAQs, and all the IBM XTs have this version, but the older PCs with the 64K system board normally do not. The Bubble Disk will operate with the older BIOS but will not boot the operating system, and a small program must be run after booting to install the board as a drive.

The board features a write-protect switch on the board bracket, accessible from outside the system unit cabinet. This switch will prevent any files on the Bubble Disk from being erased or written over. There is a jumper select option to change the function of this switch to an on-line/off-line switch for convenient operation with a fixed disk or other IPL device.

FIRST-TIME INSTALLATION

The user is encouraged to read this entire manual before installing the PC Bubble Disk. In addition, a first-time installation should be attempted on an IBM PC or XT with the following configuration:

- at least one floppy disk
- no fixed disk adapter board; remove from slot if installed

HANDLING THE BUBBLE DISK BOARD

The Bubble Disk board has static sensitive components and should be kept in its antistatic wrapping or on a similar protective surface until installation. Please handle the board only by the edges and avoid touching the gold edge connector or pressing on the metal can of the clock crystal.

CHECKING JUMPER SETTINGS

The jumper/switch settings on the Bubble Disk board should be checked at this time and placed in the default position:

JUMPER	FUNCTION	DEFAULT SETTING
J1	options	all positions jumpered
J2	EPROM addr	all positions jumpered
J3	interrupt	jumper in up position
J4	EPROM enable	jumped
J5	DACK	jumper on right side
J6	I/O port addr	all positions jumpered
J7	DRQ	jumper on right side
SW1	Write-Protect bracket switch	in up position

With these settings, the Bubble Disk is configured for single Bubble Disk operation, no fixed disk present, not write-protected, DMA channel 3, Interrupt channel 5, EPROM at address hex C8000, and card I/O port at hex 3C0-3C3.

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INSERTING THE BOARD

The Bubble Disk board will fit and seat properly in any of the full length expansion slots. Press the plastic card guide provided with the board into the holes at the end of the slot position chosen if there is not one already present.

Check that the power to the IBM PC is OFF before inserting (or removing) the Bubble Disk board. It is important to ensure that the board's gold edge connector is FULLY INSERTED into the slot. When seated properly, the top of the board's rear bracket will be against the retaining ledge, flush with the other board brackets, while the front edge of the board is held in the plastic card guide. Screw the bracket down securely before applying power.

POWERING UP FOR THE FIRST TIME

As first received, the Bubble Disk is completely cleared with zeros in all storage locations. It is necessary to first create a DOS partition with the PC-DOS 2.0 program, FDISK, and then format it with the program, FORMAT.

With the PC-DOS 2.0 diskette in drive A, turn on the power to the system. The system should boot from floppy diskette in the normal fashion. If a "1702" appears on the screen, there was a problem in initializing the Bubble Disk. The power should be shut off and the jumper settings rechecked.

Once DOS has been booted and the prompt is displayed, run the program, FDISK. If FDISK indicates that no fixed disk is present, it is possible that your system does not have the newer BIOS ROM with the ROM SCAN routine, and therefore it is necessary to run a small installation program as described in Appendix A before proceeding.

Once the FDISK menu is displayed, follow the instructions in the PC DOS 2.0 manual to create a DOS partition. Note that the operating system should be rebooted after creating partitions or changing partition size with FDISK. Rebooting notifies the operating system of the partition changes that were made.

After creating a DOS partition with FDISK, it is still necessary to format the Bubble Disk with the DOS 2.0 FORMAT program. The drive letter for the Bubble Disk will depend on the positions of switches 7 and 8 on

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SW1 of the IBM PC system board. These switches indicate how many floppy drives are installed. If two or less drives are indicated, the Bubble Disk will be drive C. If four floppy drives are indicated (7=off,8=off), then the Bubble Disk will be drive E (even if less than four floppy drives are installed). For instance, if the former is the case, then run the format program with the instruction, FORMAT C:/s/v, which will also install the operating system and allow a volume name. The Bubble disk is now installed and ready to operate.

The Bubble Disk emulates the fixed disk and can perform all the ordinary disk user commands. In addition, it will respond to special fixed disk commands, such as RESTORE and BACKUP. As is the case with the fixed disk, the diskette-only commands, such as DISKCOPY or DISKCOMP, will return an error when attempted on the Bubble Disk.

BOOTING FROM THE BUBBLE DISK

If there is an active partition on the Bubble Disk and the operating system is installed on that partition, then the Bubble Disk will boot from power-off or reset provided there is no disk in drive A or drive A's door is open.

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OTHER OPERATING SYSTEMS

Operating systems other than PC-DOS 2.0 that support the hard disk will have software similar to FDISK with which to create a hard disk partition for use by that operating system. The Bubble Disk should be considered a fixed disk when following the instructions for these programs. In some cases, the operating system will assume that the Bubble Disk has a full 306 cylinders of capacity and indicate this during the partitioning setup operation. This discrepancy should be ignored and partitioning limited to the Bubble Disk capacity of 15 cylinders per installed board.

Just as with PC-DOS, in order to boot these operating systems from the Bubble Disk, the operating system files must be installed and the partition for the desired operating system made the active partition.

PARTITIONING CP/M-86

The partition for Version 1.1 of CP/M-86 for the PC XT must start at cylinder 0 and be at least 10 cylinders long. Partitioning is done with the program, HDMINT. As mentioned above, the partition must be deliberately made active if booting is desired. As described in the CP/M supplement for the Hard Disk, the contents of the system disk, including the CCPM.SYS file needed for booting, can be copied to the Bubble Disk with the PIP command:

```
*c:=a:*.*[rv]
```

PARTITIONING SOFTECH PASCAL

The partition for Softech Pascal Version IV.13 is created using the file, DISKUTIL.I . Note that after creating the partition, the system must be rebooted before the Bubble Disk will be recognized as an on-line volume. For the Bubble Disk to boot this system, the file, SMSFDBOOT.7C00, provided on the Pascal system disk must be transferred to the Bubble Disk volume using the Filer Transfer command along with the other necessary files for system booting. Of course, the Pascal partition must be made active as well.

MULTIPLE PARTITION OPERATION AND FDISK

The PC-DOS 2.0 program, FDISK, displays a few idiosyncrasies when multiple operating systems are present and a change in the active partition is attempted. These problems are not related to the Bubble Disk, and they appear to have been corrected with DOS 2.1 .

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For instance, when two partitions are present and the first is active, an attempt to make the second partition the active partition will appear to create a third partition, at least on the display. When this happens, accept the situation and return to the main menu. Now run the "Change Active Partition" routine once more and select partition 3. This will cause the display to again indicate only two partitions with the second partition active as desired.

Another trouble mode happens when a partition is chosen to be active, but the previously active partition is not returned to normal status. As in the case above, repeat the "Change Active Partition" routine and again select the desired partition which should correct the problem.

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JUMPER OPTION SUMMARY

There are several options to the operation of the Bubble Disk that will be explained in the following sections. These options are selected by the use of the small blue jumpers on the bubble board in the area above the gold edge connector. In the following sections, "JP" designates that a jumper should be inserted at the location specified, and "NJP" signifies that the jumper should be absent or removed. Orientations, such as top, bottom, right, and left, assume the board is viewed from the component side with the gold edge connector down.

The jumpers are functionally grouped and identified on the bubble board with the designations J1 to J7 near the jumper positions. The following is a summary of the jumper groups which will be explained in succeeding sections.

GROUP J1 : MISC OPTIONS

POS	JUMPER#	JP	NJP
TOP	J1-1	SINGLE BOARD	MULTI-BOARD
	J1-2	BEFORE FIXED DISK	AFTER FIXED DISK
	J1-3	WP SELECT	ONLINE/OFFLINE
	J1-4	NORMAL	RESERVED
BOT	J1-5	NO FIXED DISK	FIXED DISK ATTACHED

GROUP J2 : EPROM ADDRESS SELECT

LEFT RIGHT ADDRESS (HEX)

JP	JP	C8000
JP	NJP	CA000
NJP	JP	CC000
NJP	NJP	CE000

GROUP J3 : INTERRUPT SELECT

JUMPER POSITION CHANNEL SELECTED

JP	TOP	INTERRUPT 5 *
JP	BOTTOM	INTERRUPT 6
NJP		NO INTERRUPT

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GROUP J4 : EPROM ENABLE

JUMPER SELECT

JP EPROM ENABLED

NJP EPROM DISABLED

GROUP J5 : DACK SELECT

JUMPER POSITION CHANNEL SELECTED

JP LEFT DACK 2

JP RIGHT DACK 3 *

NJP NO DACK

GROUP J6 : I/O PORT SELECT

LEFT RIGHT I/O PORT ADDRESS (HEX)

JP JP 3C0-3C3

JP NJP 3C4-3C7

NJP JP 3CB-3CB

NJP NJP 3CC-3CF

GROUP J7 : DRQ SELECT

JUMPER POSITION CHANNEL SELECTED

JP LEFT DRQ 2

JP RIGHT DRQ 3 *

NJP NO DRQ

* These settings for INTERRUPT, DRQ, and DACK must be used for the Bubble BIOS EPROM driver software to function properly.

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HARD DISK OPTION

The Bubble Disk will work in the IBM PC/XT with a fixed disk adapter card and a single fixed disk installed. If multiple bubble boards are on the system as described in the next section, the following jumper instructions only apply to board 1.

1) Since the ROM on the fixed disk adapter card is at address hex C8000, the Bubble Disk EPROM must be changed to a higher address using jumper J2 settings from the table below. It does not matter which higher address is chosen as long as the address does not conflict with the ROM space of any other intelligent adapter boards that might be installed on the system.

BUBBLE BOARD 1 : J2

JUMPER POSITION

LEFT	RIGHT	EPROM ADDRESS (HEX)
------	-------	---------------------

JP	JP	C8000
JP	NJP	CA000
NJP	JP	CC000
NJP	NJP	CE000

2) After jumpering an address higher than hex C8000 for the EPROM, the lowest jumper on J1 (J1-5) should be removed. This notifies the Bubble BIOS that a fixed disk is present. The system will "hang" if this jumper is not removed and a fixed disk adapter card is present on the system.

3) The Bubble Disk will be installed by the operating system with a drive letter before or after the fixed disk drive letter, depending on the setting of the second J1 jumper (J1-2) :

BUBBLE BOARD 1

J1-2 SETTING	C:(E:)	D:(F:)
--------------	--------	--------

JP	BUBBLE DISK DRIVE	FIXED DISK DRIVE
NJP	FIXED DISK DRIVE	BUBBLE DISK DRIVE

If floppy drive A is empty or its door is open during power-on or reset, the system will attempt to boot the operating system from the the first "hard disk" drive as configured above.

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MULTI-BOARD SINGLE DRIVE OPTION

Depending on the power supply capability, up to four boards can be installed in the system at one time. Each board adds an additional 15 cylinders (512 Kbytes) of storage to the Bubble Disk drive. For this configuration the following jumper settings are necessary:

- 1) The Bubble BIOS EPROM should only be enabled on one board. Choose a board as bubble board 1 and disable the EPROM on all the other additional boards by removing their jumper on J4.
- 2) Each board must have its own I/O port address space. These addresses must be consecutive, starting with address hex 3C0 on bubble board 1. Set the I/O port address space on each board with J6 as follows:

JUMPER POSITION			
J6	LEFT	RIGHT	I/O PORT
JP	JP		3C0-3C3
JP	NJP		3C4-3C7
NJP	JP		3C8-3CB
NJP	NJP	.	3CC-3CF

- 3) On bubble board 1 only, the first jumper (J1-1) from the top of J1 should be removed. This enables the multiboard option.
- 4) Finally, the TOTAL number of bubble boards should be indicated on J1 of bubble board 2 only, using the first (J1-1) and second (J1-2) jumper positions from the top of J1 as follows:

BUBBLE BOARD 2 ONLY		
J1-1	J1-2	TOTAL NUMBER OF BUBBLE BOARDS
NJP	JP	2
JP	NJP	3
NJP	NJP	4

The remaining J1 jumpers of bubble board 2 (J1-3 to J1-5), and the J1 jumpers of all higher number bubble boards are ignored. Only the J1 jumpers and bracket switch of bubble board 1 control the options described in the JUMPER OPTION SUMMARY section.

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5) After changing the number of bubble boards on a system, it is necessary to run FDISK and FORMAT to reconfigure the partition and the directory sectors to reflect the change in Bubble Disk capacity. These programs will wipe out files previously stored on the bubble boards, so the Bubble Disk should be backed-up before adding or subtracting bubble boards from the system.

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CP/M-86 WITH BUBBLE AND FIXED DISK

When the Bubble Disk is used alone with CP/M-86 FOR THE PC/XT, it will operate as a fixed disk with no patching to the operating system necessary. However, when the Bubble Disk and a fixed disk are installed together, a small patch must be applied to the CP/M operating system. This patch prevents CP/M from writing over the INT 42H location during CP/M initialization, which is where the fixed disk vector is relocated by the PC Bubble BIOS.

The following is the procedure for patching CP/M-86 for the IBM PC/XT with version number 1.1 :

1. Boot up with a PC-DOS 2.0 diskette and use DISKCOPY to copy the original CP/M-86 SYSTEM DISK to a backup diskette. Put the original SYSTEM DISK away and use the backup for the following patch.
2. With the PC-DOS 2.0 diskette run DEBUG and get the normal prompt:
A>DEBUG
-
3. Insert the backup CP/M-86 SYSTEM DISK into DRIVE A.
4. Perform the following load operation of one sector to offset 0 from sector 6C of drive A :
-L 0 0 6C 1 <cr>
5. Examine the bytes starting at offset 1B0 using the enter command, "E", and ensure that they match the following by using the spacebar and ending with the return key:
-E1B0 <cr>
XXXX:01B0 93. FC. E2. B3. C7. 08. B9. 7C.<cr>
-
If the bytes do not match, then try repeating from step 4. A repeat mismatch could indicate that the user does not have the proper version for this patch.
6. Repeat the above operation, except change two bytes as indicated:
-E1B0 <cr>
XXXX:01B0 93. FC. E2. B3. C7. 08.0C B9. 7C.78<cr>
-

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7. Finally, write the sector back to the diskette:
-W 0 0 6C 1

The CP/M SYSTEM DISKETTE is now patched and can be run normally.

INTERFACE DESCRIPTION

The interface for a single PC Bubble Disk card uses four consecutive I/O port addresses starting at hex 3C0. In multi-board operation, each additional board must be jumpered to use the next four I/O port addresses adjacent to the previously installed board. A maximum of four boards may be installed which would use I/O port addresses hex 3C0 to 3CF.

The first two I/O port addresses of each board provide direct access to the registers of the Intel 7220-1 Bubble Memory Controller (BMC). The commands and operation of the BMC are well documented in the Intel Memory Components Handbook or the BPK-72 Bubble Memory Prototype Kit Users Manual which are available from Intel (Order No. 210830 and 121685 respectively).

The third I/O port address permits reading the J1 switches and the INT and DRQ lines from the BMC and writing to the INT and DMA selects. The DMA select enables/disables the tristate gate between the DRQ of the BMC and the jumper-selected DRQ of the system expansion bus and enables/disables functioning of the DACK signal to the BMC. The INT select enables/disables the tristate gate between the INT from the BMC and the jumper-selected INT of the system bus. The fourth I/O port address is not decoded and functions the same as the third I/O port.

The following table summarizes the functions of the four port addresses for board 1. The port functions for boards 2,3, and 4 are the same except they start at 3C4,3C8, and 3CC respectively.

R/W	PORT(BRD 1)	FUNCTION	
READ	3C0	BMC DATA REG	(A0 = 0)
WRITE	3C0	BMC DATA REG	(A0 = 0)
READ	3C1	BMC STATUS REG	(A0 = 1)
WRITE	3C1	BMC CMD/RAC REG	(A0 = 1)
READ	3C2	J1/INT/DRQ	
WRITE	3C2	DMA/INT SELECT	
READ	3C3	SAME AS 3C2	
WRITE	3C3	SAME AS 3C2	

As indicated, port 3C2 provides access to the settings of the jumpers on group J1. The specific bit assignments of port 3C2 for both reading and writing are shown in the tables below. When there is no jumper at a particular J1 position (NJP), then the bit for that option is set (bit=1)

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and vice versa. The BMC DRQ and INT lines and their function and operation are documented in the Intel handbooks listed above.

POR T 3C2

BIT	READ OPERATION	WRITE OPERATION
80	BMC DRQ	DMA (ENABLE=1)
1	BMC INT	INT (ENABLE=1)
2	SW1 (UP = 0)	NO CONNECTION (NC)
3	J1-5 FIXED DISK OPTION	NC
4	J1-1 MULTIBOARD OPTION	NC
5	J1-2 BEFORE/AFTER FIXED DISK	NC
6	J1-3 WP/ONLINE SELECT	NC
7	J1-4 RESERVED (DIAGNOSTICS)	NC

BIOS LEVEL OPERATION

The PC Bubble Disk emulates the fixed disk at the BIOS level. That is, where appropriate, the Bubble Disk BIOS commands are the same in format and function as the fixed disk BIOS commands listed in the IBM PC Technical Reference manual (page A-87).

APPENDIX A

AUTO SCAN BIOS ROM

The PCs with 256K motherboards and all XT's have the newer BIOS ROM with the ROM_SCAN routine. On power-up or reset, this routine scans addresses hex C8000 to F6000 looking for ROMs from intelligent adapter cards installed in the system. When a ROM is recognized, an initialization routine at offset hex 3 from the ROM's starting address is called. The Bubble Disk board has an EPROM that is recognized by the SCAN routine, and its initialization routine installs the necessary software hooks for the Bubble Disk to function as a fixed disk. This is done before the operating system bootstrap is attempted, thus allowing the Bubble Disk to perform this boot when desired. No additional installation software is required for Bubble Disk operation.

However, if you have one of the older PCs without the ROM_SCAN routine on the BIOS ROM, then it is not possible to boot from the Bubble Disk, and a small installation program to be described below must be run after booting.

DETERMINING IF ROM_SCAN PRESENT

One can determine if the ROM_SCAN routine is present on the BIOS ROM by examining the release date of the BIOS at location hex FFFF:5 using the DEBUG program on the PC-DOS disk. To do this, follow these steps:

```
A>DEBUG <cr>
-D FFFF:5 L8 <cr>
FFFF:0005  31 30 2F-32 37 2F 38 32           10/27/82
-Q <cr>
```

A release date of 10/27/82 or later indicates that the ROM SCAN routine is present on the BIOS ROM.

BUBBLE INSTALLATION WITHOUT ROM SCAN FEATURE FOR PC-DOS

Without the ROM SCAN feature it is not possible to boot directly from the Bubble Disk, and a small program must be run upon bootup. This program is easily created with DEBUG program from the PC-DOS disk as follows:

```
A>DEBUG <cr>
-N BUBBLE.COM <cr>
```

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```
-L <cr>
File not found
-A <cr>
XXXX:0100 CALL FAR C800:3 <cr>
XXXX:0105 INT 19 <cr>
XXXX:107 <cr>
-R BX <cr>
BX XXXX
:B <cr>
-R CX <cr>
CX XXXX
:7 <cr>
-W <cr>
Writing 0007 bytes
-Q <cr>
```

The above operation has created a COM file called BUBBLE.COM. It calls the initialization routine of the Bubble Disk EPROM and then reboots the system. This procedure causes PC-DOS 2.0 to install the Bubble Disk as a fixed disk drive. Note that if BUBBLE.COM is run more than once after a cold boot, the system will "hang" the second time. Likewise, BUBBLE.COM should not be placed in an AUTOEXEC.BAT file since this will cause the system to call BUBBLE.COM a second time.

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APPENDIX B

SPECIFICATIONS

	Bubble Boards Installed			
	one	two	three	four
TOTAL STORAGE (Kbytes):	512	1024	1536	2048

MEMORY ORGANIZATION :

(Hard Disk Emulation)

cylinders	15	30	45	60
heads/cylinder	4			
sectors/track	17			

DMA:

jumper-selectable channel 2 or 3

INTERRUPT:

jumper-selectable channel 5 or 6

BUBBLE BIOS EPROM ADDRESS:

jumper-selectable C8000H, CA000H, CC000H, or CE000H

I/O PORT ADDRESS:

jumper-selectable 3C0H-3C3H, 3C4H-3C7H, 3CBH-3CBH, or 3CCH-3CFH

MEAN ACCESS TIME:

48 nsec

MAX. DATA TRANSFER RATE (BURST):

50 Kbytes/sec

(200 Kbytes/sec during last page of READ)

AVE. DATA TRANSFER RATE:

34 Kbytes/sec

BUBBLE MEMORY OPERATING TEMPERATURE:

10 to 55°C Case

NON-VOLATILE STORAGE TEMPERATURE:

-20 to 75°C

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SUPPLY VOLTAGE REQUIREMENTS:

Voltage	Margin	Power Off/Fail Decay Rate
+12 volts	+5%	<1.10 volts/msec
+ 5 volts	+5%	<0.45 volts/msec

TYPICAL CURRENT REQUIREMENTS:

Voltage	Mode	Bubble Boards Installed			
		One (ma)	Two (ma)	Three (ma)	Four (ma)
+12 Volts	Standby	160	320	480	640
	read/write	1800	1160	1320	1480
+5 Volts	Standby	490	980	1470	1960
	read/write	500	990	1480	1970

